LEADER

LPS-160A/-1 SERIES

REGULATED DC POWER SUPPLY

SERVICE MANUAL

CARNEL LABS CORPORATION

LEADER

LPS-160A/-1 SERIES

REGULATED DC POWER SUPPLY

SERVICE MANUAL

Models covered

32V Series	18V Series
LPS-160A	LPS-160-1
LPS-161A	LPS-160-2
LPS-162A	LPS-160-3
LPS-163A	LPS-160-4
LPS-164A	LPS-160-5

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NOTE

These servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing other than that contained in the service manual unless you are qualified to do so.

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1. SPECIFICATIONS

MODEL	LPS-160A	LPS-161A
Output voltage	0 ~ 32 V Continuously variable	
Output polarity	Positive and negative	
Output current	0 ~ 0.5A	0 ~ 1.2A
Ripple voltage	Less than 3mVp-p	
Output stability	Less than 5mV for power source voltage change of ± 10% Less than 5mV for load variation of 0 to 100%	
Voltmeter	40V (F.S) Accuracy of 2.5% for full scale	
Amperemeter	0.6A (F.S) Accuracy of 2.5% for full scale	1.5A (F.S) Accuracy of 2.5% for full scale
Insulation	Between chassis and output terminal: More than 10 MΩ at DC 500V Between chassis and AC plug: More than 50MΩ at DC 500V	
Compensation/ protection circuit	Overload protection circuit of constant current self-restoring type	
Ambient temperature range	0 ~ + 40°C	
Power Source	AC 100 ~ 120V 50/60Hz 47VA	AC 100 ~ 120V 50/60Hz 93VA
	AC 200 ~ 240V 50/60Hz 47VA	AC 200 ~ 240V 50/60Hz 93VA
Size and weight	175(H) x 100(W) x 195(D)mm 3.5 kg	
Accessories	Short-circuit bar x 1 Fuse x 1	
Operation	Series and parallel	

Model	LPS-162A	LPS-163A	LPS-164A
Output voltage	0 ~ 32V continuously variable		
Output polarity	Positive and negative		
Output current	0 ~ 2A	0 ~ 3A	0 ~ 5A
Ripple voltage	Less than 3 mVp-p		
Output stability	Less than 5mV for power source voltage change of ± 10% Less than 5mV for load variation of 0 to 100%		
Voltmeter	40V (F.S) Accuracy of 2.5% for full scale		
Amperemeter	2.5A (F.S) Accuracy of 2.5% for full scale	4A (F.S) Accuracy of 2.5% for full scale	6A (F.S) Accuracy of 2.5% for full scale
Insulation	Between chassis and output terminal: More than 10 MΩ at DC 500V Between chassis and AC plug: More than 50MΩ at DC 500V		
Compensation/ protection circuit	Overload protection circuit of constant current self-restoring type		
Ambient temperature range	0 ~ + 40°C		
Power source	AC100 ~ 120V 50/60Hz 163VA	AC100 ~ 120V 50/60Hz 220VA	AC100 ~ 120V 50/60Hz 340VA
	AC200 ~ 240V 50/60Hz 163VA	AC200 ~ 240V 50/60Hz 220VA	AC200 ~ 240V 50/60Hz 340VA
Size and weight	175(H)x115(W) x225(D)mm 7kg	175(H)x150(W) 300(D)mm 8 kg	175(H)x150(W) 300(D)mm 8.8 kg
Accessories	Short-circuit bar x 1 Fuse x 1		
Operation	Series and parallel		

MODEL	LPS-160-1	LPS-160-2
Output voltage	0 ~ 18 V Continuously variable	
Output polarity	Positive and negative	
Output current	0 ~ 1A	0 ~ 2A
Ripple voltage	Less than 3mVp-p	
Output stability	Less than 5mV for power source voltage change of ± 10% Less than 5mV for load variation of 0 to 100%	
Voltmeter	20V (F.S) Accuracy of 2.5% for full scale	
Amperemeter	1.2A (F.S) Accuracy of 2.5% for full scale	2.5A (F.S) Accuracy of 2.5% for full scale
Insulation	Between chassis and output terminal: More than 10 MΩ at DC 500V Between chassis and AC plug: More than 50MΩ at DC 500V	
Compensation/ protection circuit	Overload protection circuit of constant current self-restoring type	
Ambient temperrature range	0 ~ +40°C	
Power Source	AC 100 ~ 120V 42VA (50/60Hz)	AC 100 ~ 120V 90VA (50/60Hz)
	AC 200 ~ 240V 42VA (50/60Hz)	AC 200 ~ 240V 90VA (50/60Hz)
Size and weight	175(H) x 100(W) x 195(D)mm 3.5 kg	
Accessories	Short-circuit bar x 1 Fuse x 1	
Operation	Series and parallel	

Model	LPS-160-3	LPS-160-4	LPS-160-5
Output voltage	0 ~ 18V continuously variable		
Output polarity	Positive and negative		
Output current	0 ~ 3A	0 ~ 4.5A	0 ~ 5.5A
Ripple voltage	Less than 3 mVp-p		
Output stability	Less than 5mV for power source voltage change of ± 10% Less than 5mV for load variation of 0 to 100%		
Voltmeter	20 (F.S) Accuracy of 2.5% for full scale		
Amperemeter	4A (F.S) Accuracy of 2.5% for full scale	5.4A (F.S) Accuracy of 2.5% for full scale	6.4A (F.S) Accuracy of 2.5% for full scale
Insulation	Between chassis and output terminal: More than 10 MΩ at DC 500V Between chassis and AC plug: More than 50MΩ at DC 500V		
Compensation/ protection circuit	Overload protection circuit of constant current self-restoring type		
Ambient temperature range	0 ~ +40°C		
Power source	AC100 ~ 120V 50/60Hz 170VA	AC100 ~ 120V 50/60Hz 230VA	AC100 ~ 120V 50/60Hz 265VA
	AC200 ~ 240V 50/60Hz 170VA	AC200 ~ 240V 50/60Hz 230VA	AC200 ~ 240V 50/60Hz 265VA
Size and weight	175(H)x115(W) x225(D)mm 7kg	175(H)x150(W) 300(D)mm 7.5 kg	175(H)x150(W) 300(D)mm 7.5 kg
Accessories	Short-circuit bar x 1 Fuse x 1		
Operation	Series and parallel		

2. TEST EQUIPMENT REQUIRED

The following test equipment is required for calibration and servicing of the Model LPS-160A/-1 Series. The suggested specifications are the minimum necessary for proper calibration of this instrument.

Test Equipment	Minimun Spec.
- Multimeter	3-1/2 Digit
- Oscilloscope	5mV sensitivity 1MHz band width Low capacitance probe
- Resistor/Rheostat	Correspond to Voltage/Current (Ref: Table 4-1)

3. CALIBRATION PROCEDURE

- Calibration should be performed after a 30 minute warm-up period. It should also be confirmed that the unit is connected to the rated power line voltage.

- All adjustment should be completed in the given order, because some adjustments interact with others.

- During the adjustment procedure, remove the case only when necessary and replace immediately after making an adjustment. This will maintain all circuit at constant operating temperature.

3.1 Initial Control Settings

The initial control settings to be used for each check and adjustment are listed below. Any variations from these settings are stated in the applicable procedure.

- VOLTAGE	
COARSE	Fully counterclockwise
FINE	Fully counterclockwise
- CURRENT	Fully counterclockwise

- Connect the SHORTING BAR between "-" and GND terminal.

3.2 Power Supply

- Connect the DC voltmeter to test point and check all supplies according to Table 3-1.

Table 3-1

Model	Test point	Voltage	Test point	Voltage
160A	Collector of TR1	+55V	Input of IC1	+16V
161A	Collector of TR1	+32V	Collector of TR5	+21V
162A	Collector of TR1	+23V	Collector of TR8	+16V
163A	Collector of TR1	+23V	Collector of TR8	+16V
164A	Collector of TR1	+15.5V	Collector of TR5	+17V
160-1	Collector of TR1	+35V	Input of IC1	+16V
160-2	Collector of TR1	+21V	Collector of TR5	+16V
160-3	Collector of TR1	+17V	Collector of TR8	+16V
160-4	Collector of TR1	+17V	Collector of TR8	+16V
160-5	Collector of TR1	+17V	Collector of TR8	+16V

3.3 Reference Level Adjustment

- Connect the DC voltmeter between "+" and GND terminal.

- Adjust following adjustment for the DC voltmeter reading of -5mV.

Table 3-2

Model	Adjustment
160A	VR4
161A	VR4
162A	VR5
163A	VR5
164A	VR2
160-1	VR4
160-2	VR4
160-3	VR5
160-4	VR5
160-5	VR5

3.4 Current Limiter Adjustment

- Set: VOLTAGE

COARSE	Fully counterclockwise
FINE	Center
CURRENT	Fully clockwise

Connect the short piece of wire between "+" and GND terminal. (Short three terminals together)

- Adjust following adjustment for the AMMETER reading of indicated value in Table 3-3.

Table 3-3

Model	AMMETER	Adjustment
160A	0.53A	VR2
161A	1.3A	VR2
162A	2.15A	VR3
163A	3.2A	VR3
164A	5.3A	VR1
160-1	1.1A	VR2
160-2	2.15A	VR2
160-3	3.2A	VR3
160-4	4.8A	VR3
160-5	5.8A	VR3

3.5 Tap Selector Adjustment

* The Tap Selector selects secondary taps of the power transformer by setting of VOLTAGE control to operate the series regulator at suitable condition.

- The Tap Selector should be turned on or off automatically when VOLTAGE control is adjusted around following voltage. (The audible click is able to hear as ralay energizes or de-energizes).

Table 3-4

Model	VOLT.	Adj.	VOLT.	Adj.	VOLT.	Adj.	VOLT.	Adj.
160A	-	-	-	-	-	-	-	-
161A	14-17V	VR1	-	-	-	-	-	-
162A	10-12V	VR2	22-24V	VR1	-	-	-	-
163A	10-12V	VR2	22-24V	VR1	-	-	-	-
164A	6-7.2V	-	12-14V	-	19-22V	-	25-27V	-
160-1	-	-	-	-	-	-	-	-
160-2	9-10V	VR1	-	-	-	-	-	-
160-3	6-7V	VR2	13-14V	VR1	-	-	-	-
160-4	6-7V	VR2	13-14V	VR1	-	-	-	-
160-5	6-7V	VR2	13-14V	VR1	-	-	-	-

4. TROUBLESHOOTING PROCEDURE

4.1 Troubleshooting Aids

- Confirm that the any equipment used with the 160A/-1 series is operating correctly. If there is any question about the function, see the INSTRUCTION MANUAL for a correct operation.

- Check all control settings, because an incorrect setting can make a good unit appear defective. If there is any question about the function, see the INSTRUCTION MANUAL for a correct operation.

- Some trouble can be solved with proper adjustment.

- Check all circuit for visual defects such as broken components, loose connections and poor soldering which could be a cause of trouble.

- Check DC voltage and waveform as shown in the schematic diagram to locate the defective circuit. Start with the power supply.

  Typical voltage and waveform are obtained under the same conditions as "3.1 Initial Control Settings".

  The voltage at dotted line in the Block Diagram will be elevated up to 32V/18V by settings of the VOLTAGE control. Therefore, the most DC voltages should be read in addition to the VOLTMETER indication.

4.2 Check-out Procedure

- Setup

  Connect the appropriate resistor (and/or rheostat in series) between "+" and GND terminal. (See Table 4-1)

  Connect the oscilloscope to "+" and GND terminal to check a ripple.

- Set the VOLTAGE control to 32/18V. (See Table 4-1)

- The AMMETER reading should be about as follows. (See Table 4-1)

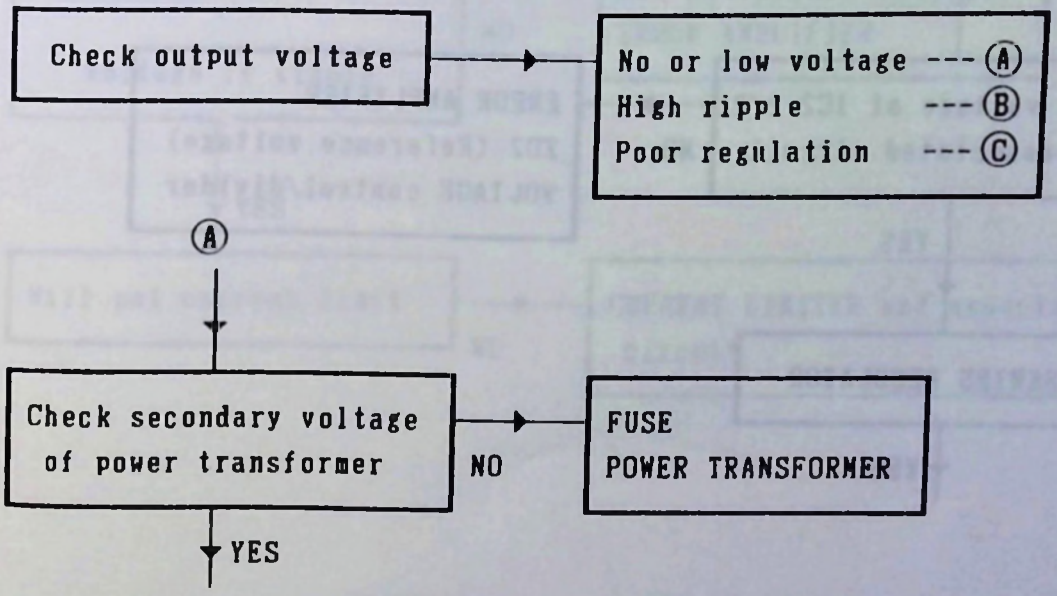
Table 4-1

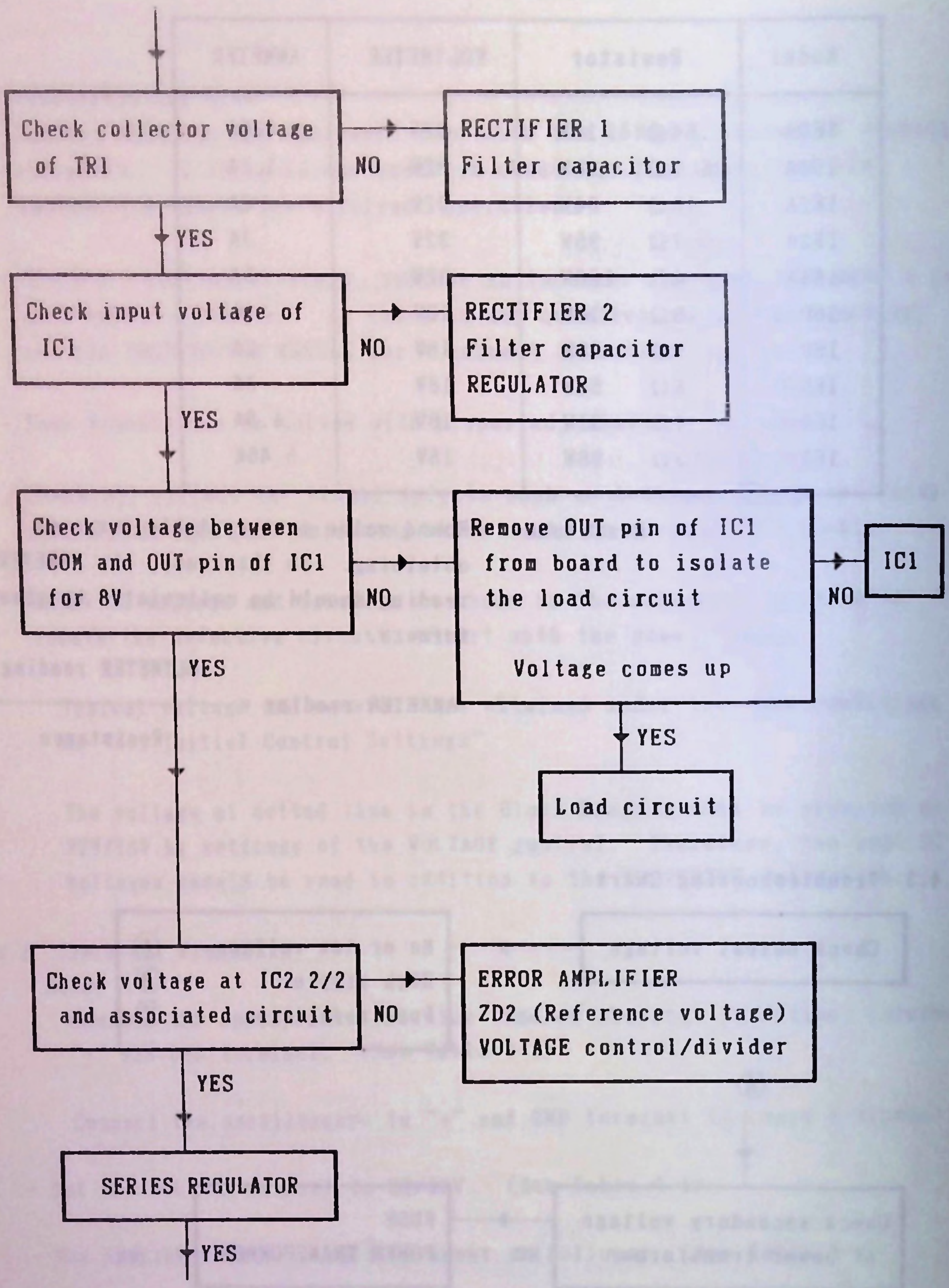
Model	Resistor		VOLTMETER	AMMETER
160A	64Ω	16W	32V	0.5A
161A	26.7Ω	38W	32V	1.2A
162A	16Ω	64W	32V	2A
163A	10.7Ω	95W	32V	3A
164A	6.4Ω	160W	32V	5A
160-1	18Ω	18W	18V	1A
160-2	9Ω	36W	18V	2A
160-3	6Ω	54W	18V	3A
160-4	4Ω	81W	18V	4.5A
160-5	3.3Ω	98W	18V	5.45A

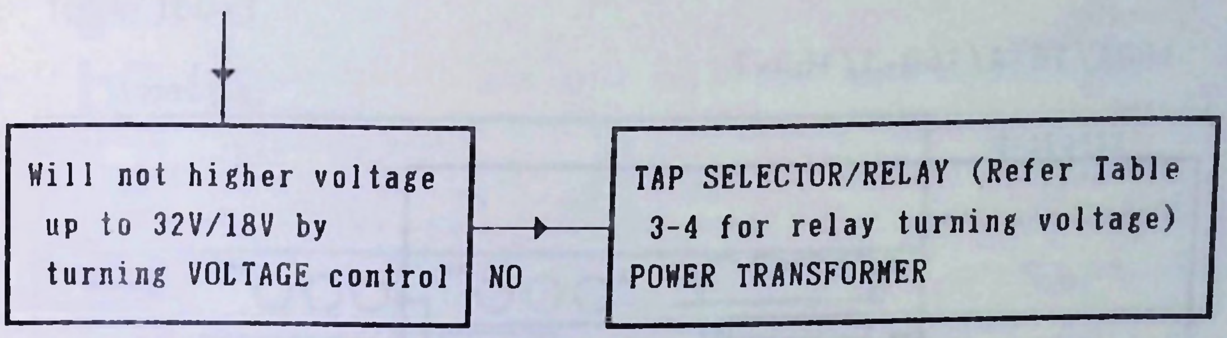
⇧ Resistance: Round value is acceptable for easy obtaining. In this case, the AMMETER reading should be caliculated by given formura.

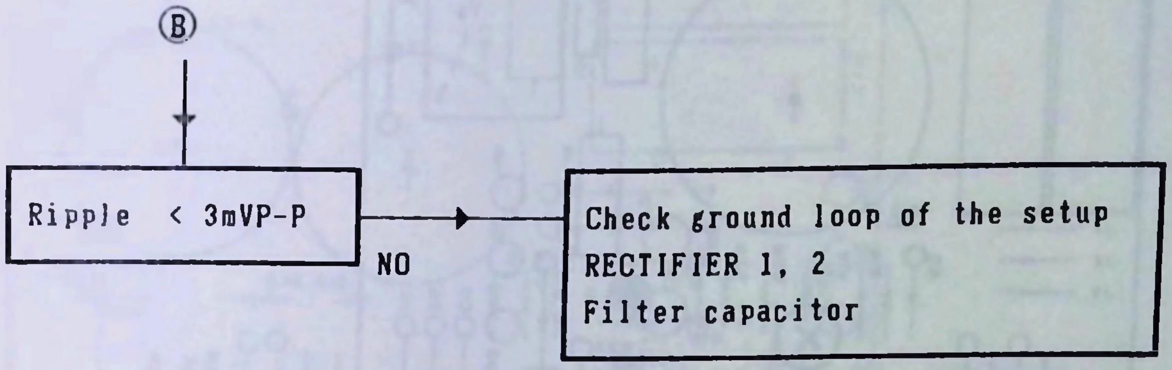
$$\text{AMMETER reading} = \frac{\text{VOLTMETER reading}}{\text{Resistance}}$$

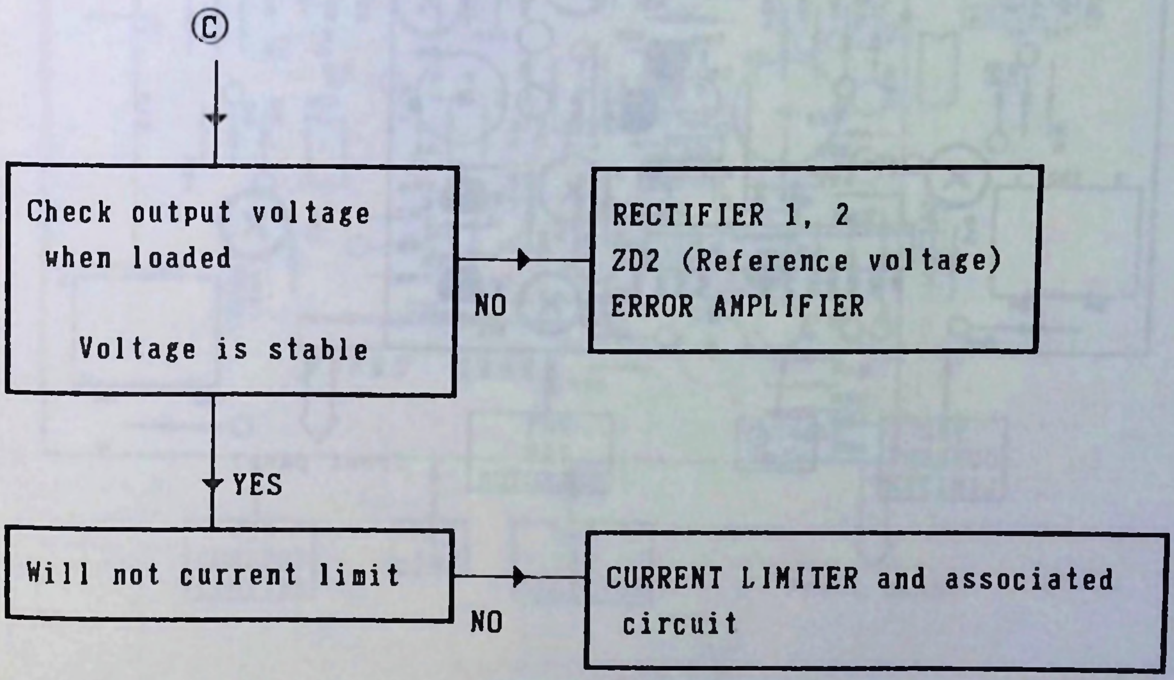
4.3 Troubleshooting Chart




Check collector voltage of TR1
NO
RECTIFIER 1
Filter capacitor
YES
Check input voltage of IC1
NO
RECTIFIER 2
Filter capacitor
REGULATOR
YES
Check voltage between COM and OUT pin of IC1 for 8V
NO
Remove OUT pin of IC1 from board to isolate the load circuit
Voltage comes up
NO
IC1
YES
Load circuit
YES
Check voltage at IC2 2/2 and associated circuit
NO
ERROR AMPLIFIER
ZD2 (Reference voltage)
VOLTAGE control/divider
YES
SERIES REGULATOR
YES

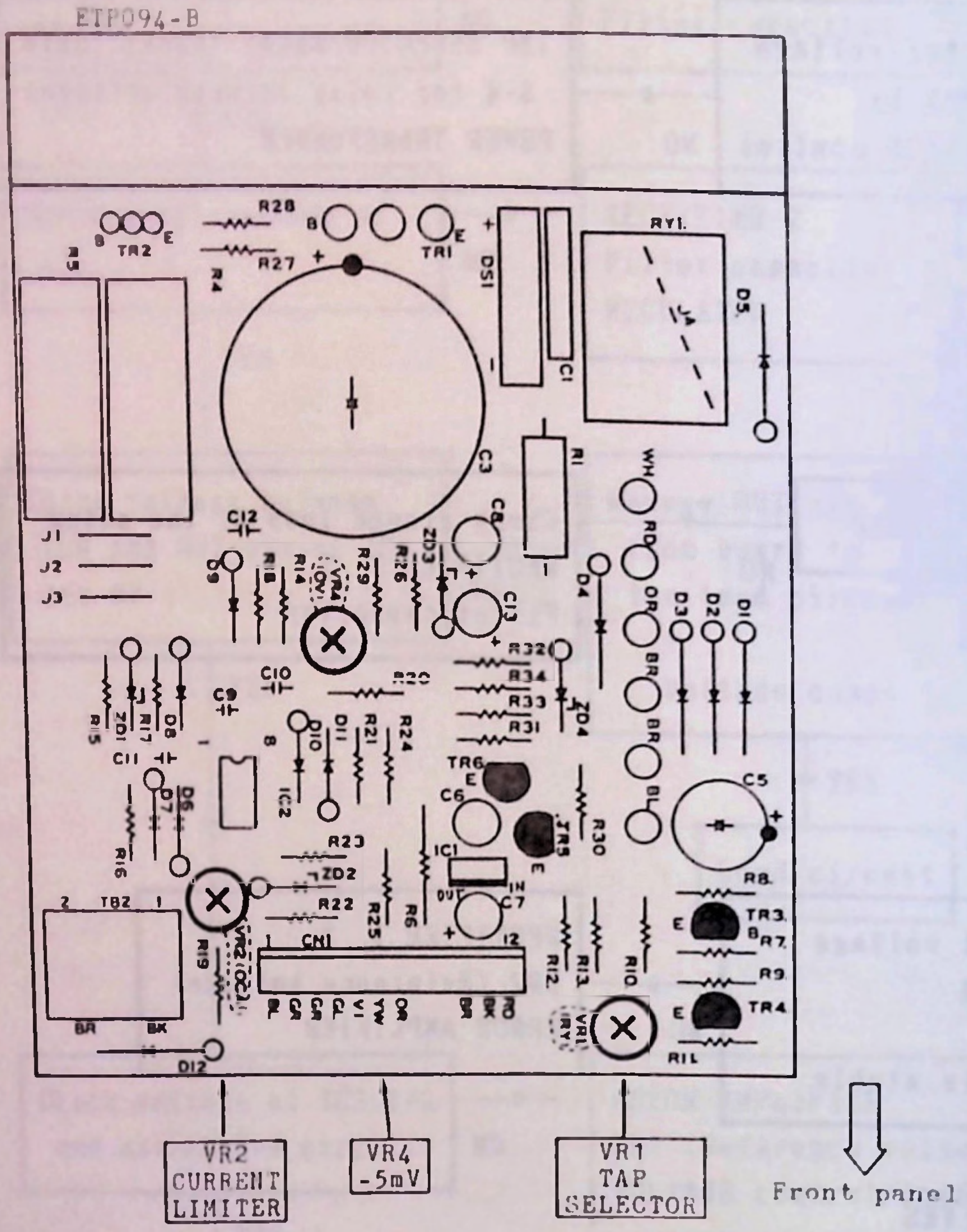

Will not higher voltage up to 32V/18V by turning VOLTAGE control
NO
TAP SELECTOR/RELAY (Refer Table 3-4 for relay turning voltage)
POWER TRANSFORMER


Ⓑ
Ripple < 3mVP-P
NO
Check ground loop of the setup
RECTIFIER 1, 2
Filter capacitor


Ⓒ
Check output voltage when loaded
Voltage is stable
NO
RECTIFIER 1, 2
ZD2 (Reference voltage)
ERROR AMPLIFIER
YES
Will not current limit
NO
CURRENT LIMITER and associated circuit

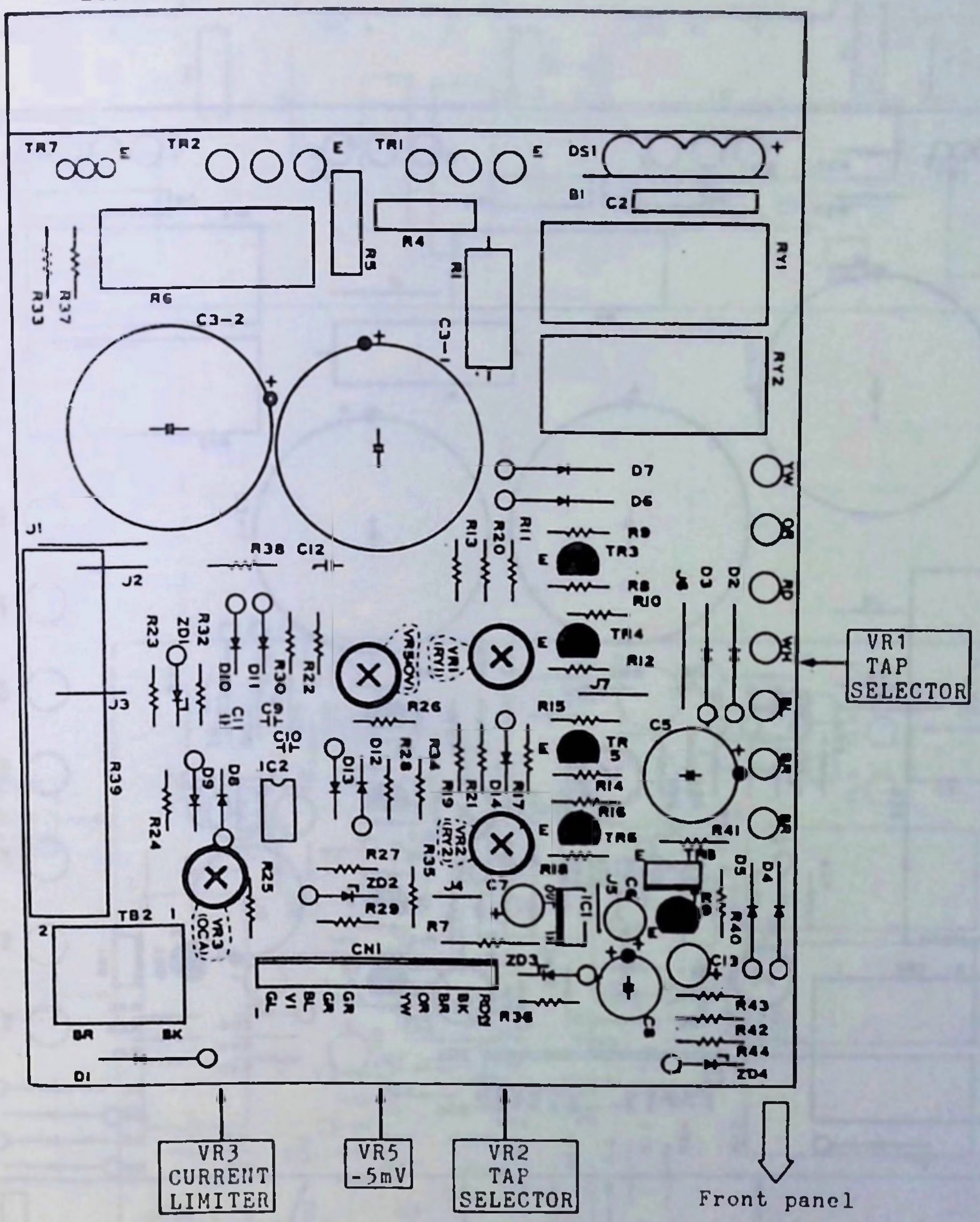
5. PRINTED CIRCUIT BOARD/ADJUSTMENT LOCATIONS

5.1 160A/161A/160-1/160-2

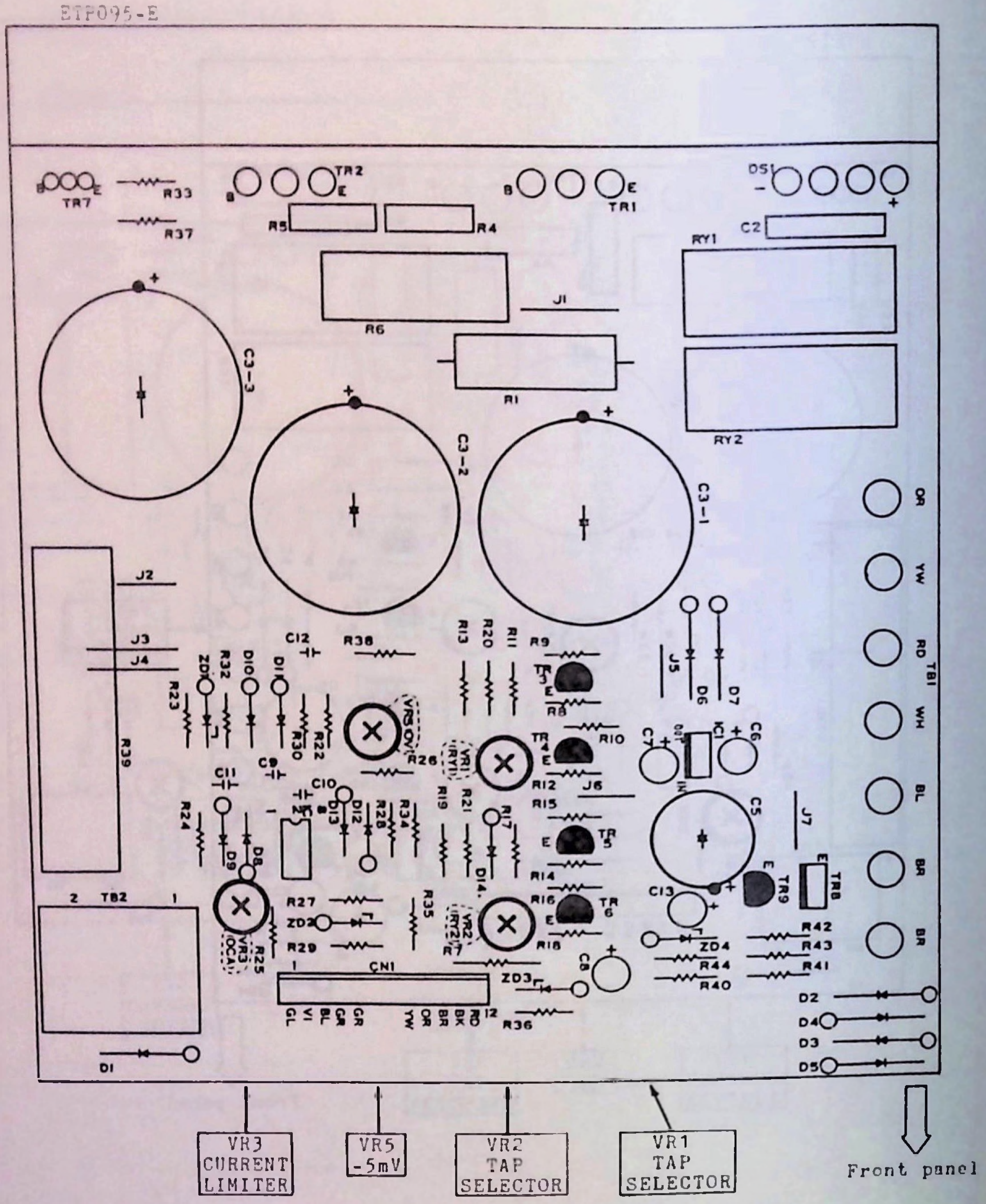


5.2 162A/160-3

ETP101-C



5.3 163A/160-4/160-5



VR3
CURRENT
LIMITER

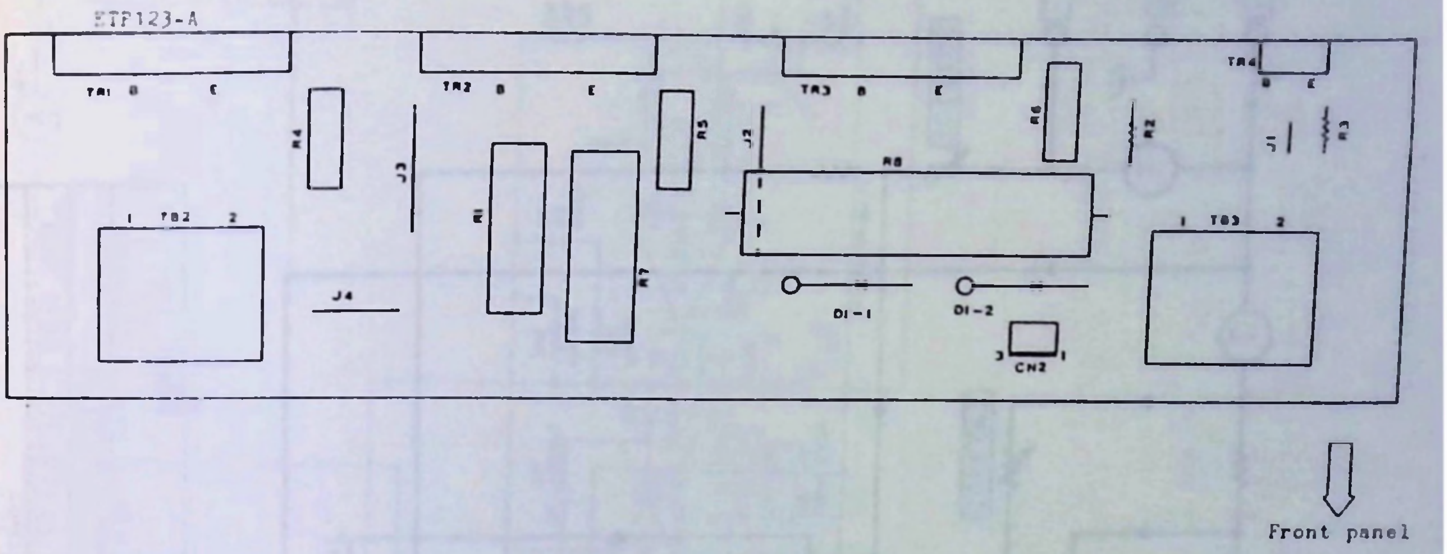
VR5
-5mV

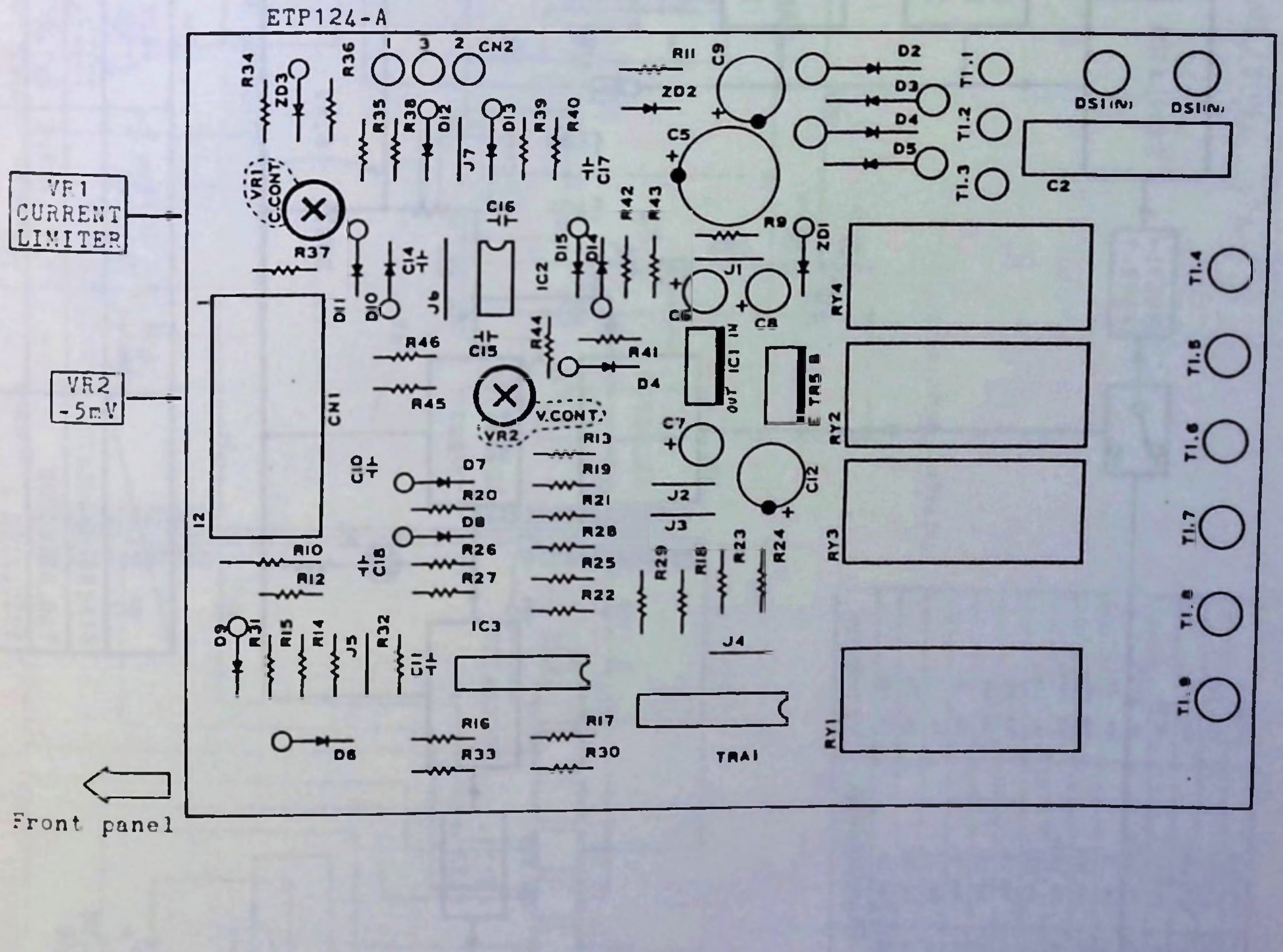
VR2
TAP
SELECTOR

VR1
TAP
SELECTOR

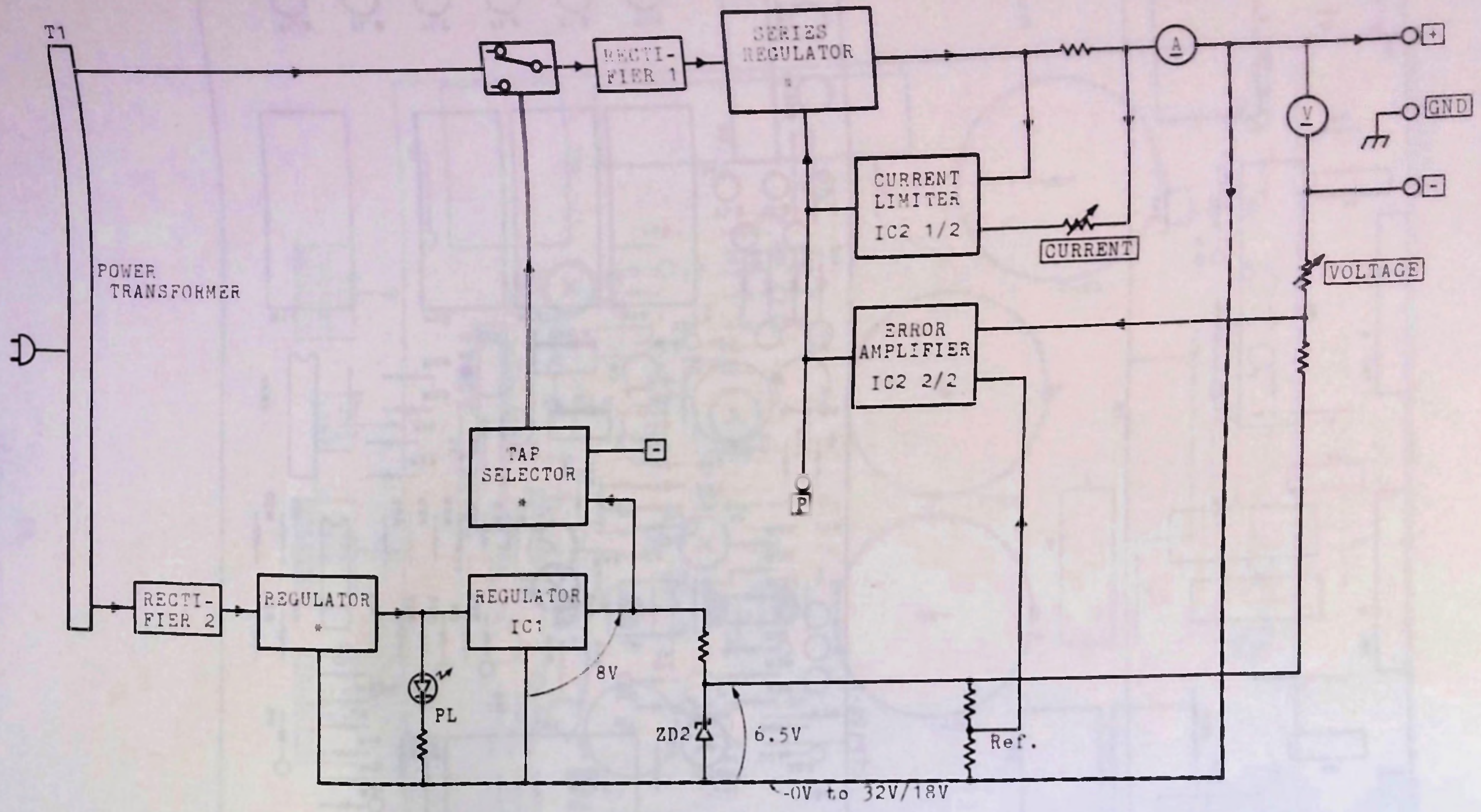
Front panel

5.4 164A


ETP123-A
TR1 B E
TR2 B E
TR3 B E
TR4 B E
R1
R2
R3
R4
R5
R6
R7
R8
J1
J2
J3
J4
1 TB2 2
1 TB3 2
D1-1
D1-2
3 CN2 1
Front panel


ETP124-A
VR1 CURRENT LIMITER
VR2 -5mV
VR1 C.CONT
VR2 V.CONT.
1 3 2 CN2
CN1
IC1 IN OUT
IC2
IC3
TR5 B E
TRA1
RY1
RY2
RY3
RY4
DS1(N)
DS1(N)
T1.1
T1.2
T1.3
T1.4
T1.5
T1.6
T1.7
T1.8
T1.9
ZD1
ZD2
ZD3
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11
D12
D13
D14
D15
C2
C5
C6
C7
C8
C9
C10
C11
C12
C14
C15
C16
C17
C18
J1
J2
J3
J4
J5
J6
J7
R9
R10
R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
R21
R22
R23
R24
R25
R26
R27
R28
R29
R30
R31
R32
R33
R34
R35
R36
R37
R38
R39
R40
R41
R42
R43
R44
R45
R46
Front panel

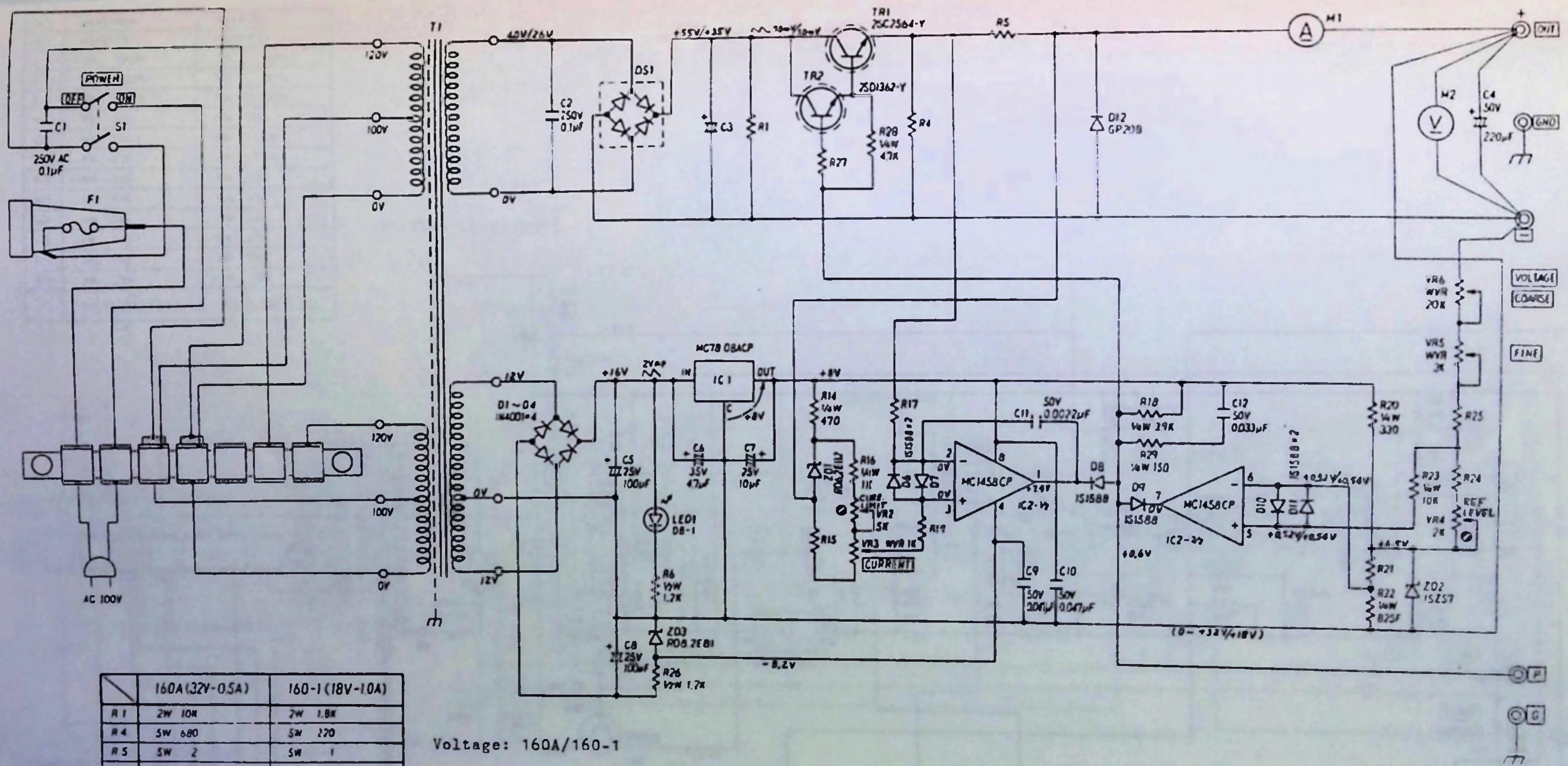
6. BLOCK DIAGRAM



*

	160A 160-1	161A 160-2	162A, 163A 160-3,-4,-5	164A
SERIES REGULATOR	TR1,2	TR1,2	TR1,2,7	TR1,2,3,4
TAP SELECTOR	-	ry1 TR3,4	ry1,2 TR3,4,5,6	ry1,2,3,4 IC3 TRA1
REGULATOR 2	-	TR5	TR8	TR5

7. SCHEMATIC DIAGRAM

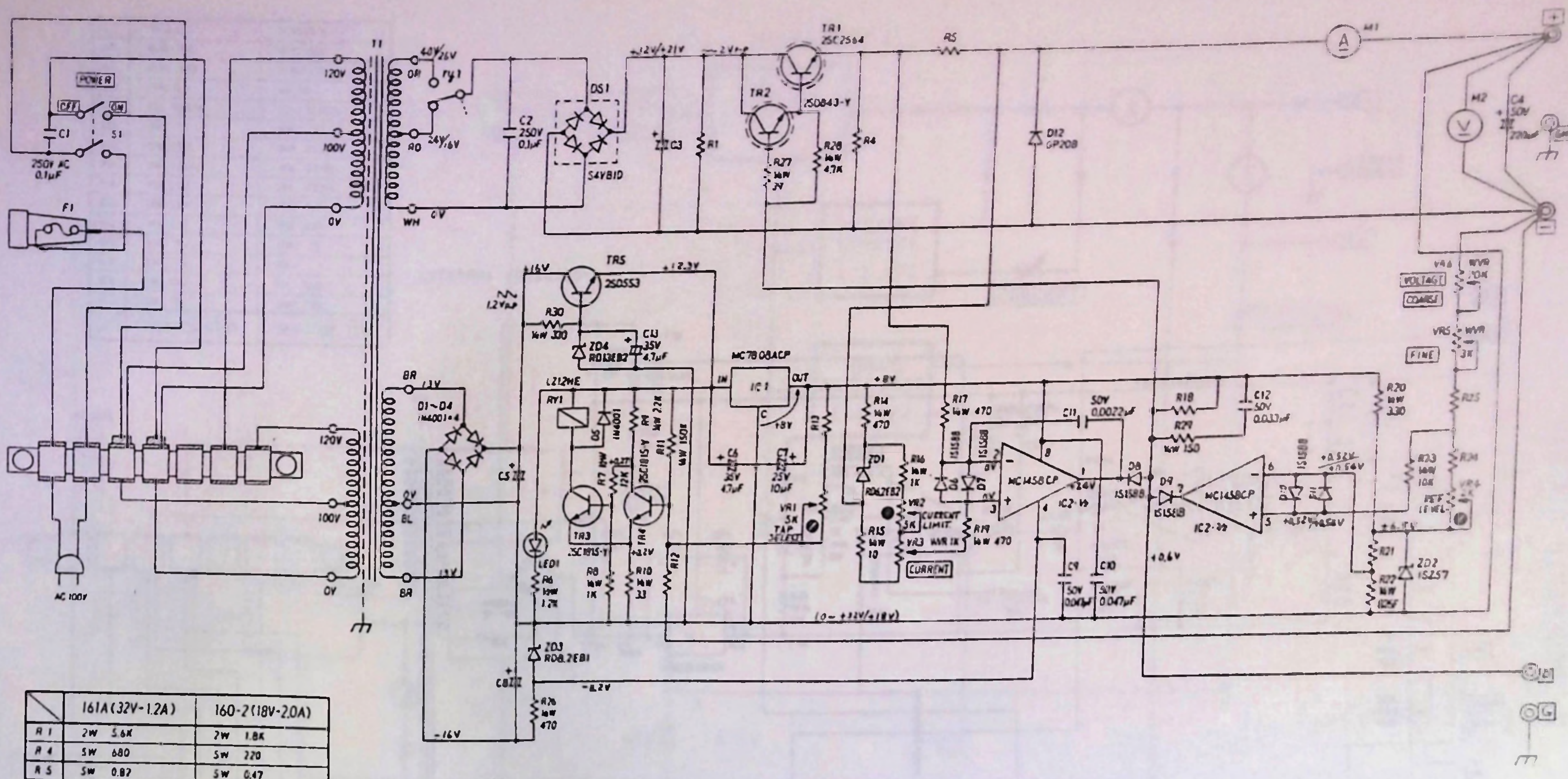


	160A(32V-0.5A)	160-1(18V-1.0A)
R 1	2W 10K	2W 1.8K
R 4	5W 680	5W 220
R 5	5W 2	5W 1
R15	¼W 22	¼W 10
R17	¼W 270	¼W 470
R19	¼W 270	¼W 470
R21	¼W 9.1KF	¼W 9.53KF
R24	¼W 3.01KF	¼W 5.11KF
R25	¼W 332F	¼W 562F
R27	¼W 10	¼W 39
C 3	80V 1000µF	50V 4700µF
DS1	S4VB10	KBL02
M 1	MF45-0.6A	MF45-1.2A
M 2	MF45-40V	MF45-20V
T 1	LD1123-3	LD0223-3

Voltage: 160A/160-1

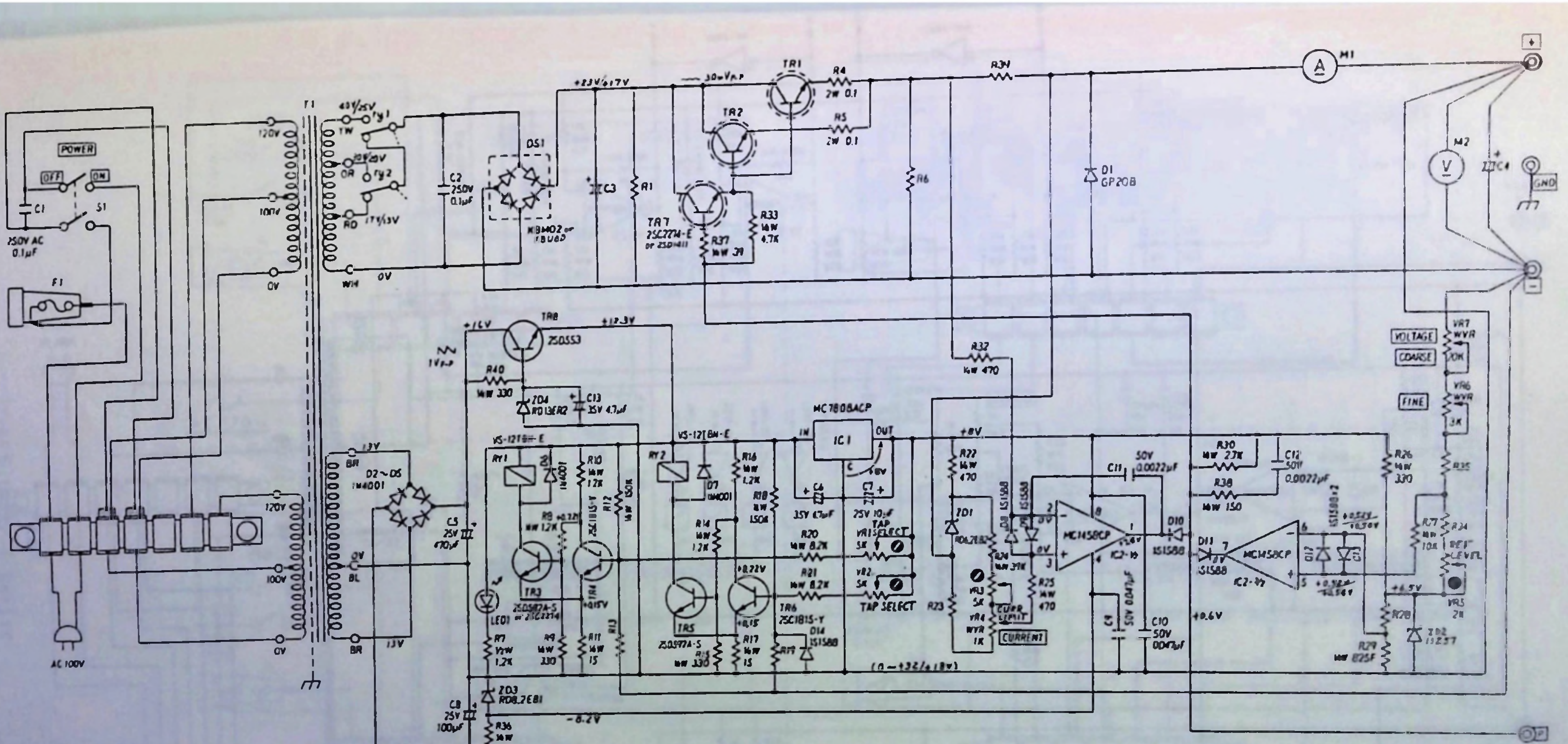
7.1 160A/160-1

7.2 161A/160-2



Voltage: 161A/160-2

	161A(32V-1.2A)	160-2(18V-2.0A)
R 1	2W 5.6K	2W 1.8K
R 4	5W 680	5W 220
R 5	5W 0.82	5W 0.47
R12	¼W 24K	¼W 12K
R13	¼W 6.8K	¼W 8.2K
R18	¼W 3.9K	¼W 2.7K
R21	¼W 9.1KF	¼W 9.53KF
R24	¼W 3.01KF	¼W 5.11KF
R25	¼W 332F	¼W 562F
C 3	80V 3300μF	50V 10000μF
C 5	25V 220μF	25V 100μF
C 8	25V 100μF	25V 47μF
M 1	MF45-1.5A	MF45-2.5A
M 2	MF45-40V	MF45-20V

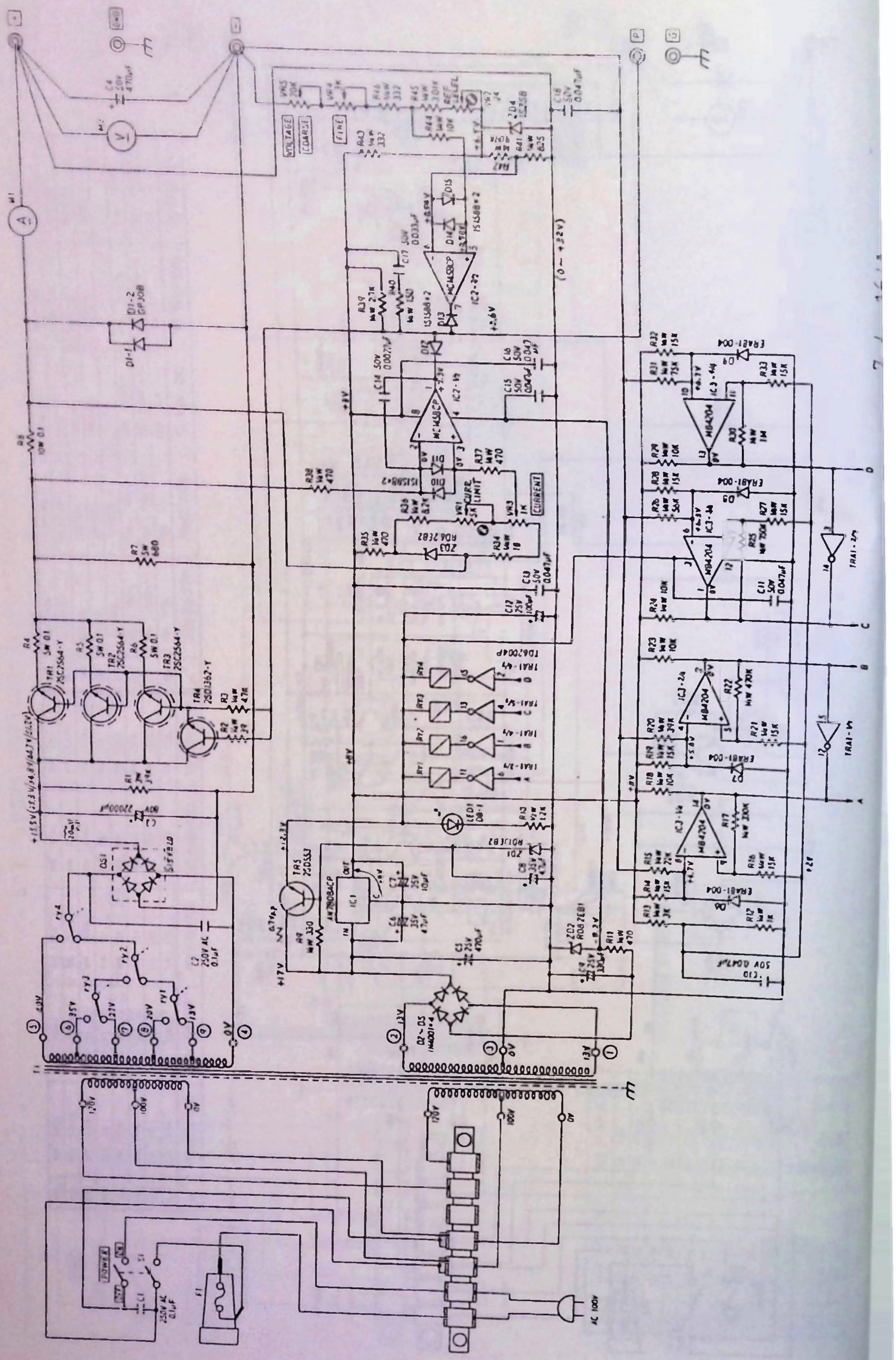


Voltage:
162A,163A/160-3,160-4,160-5

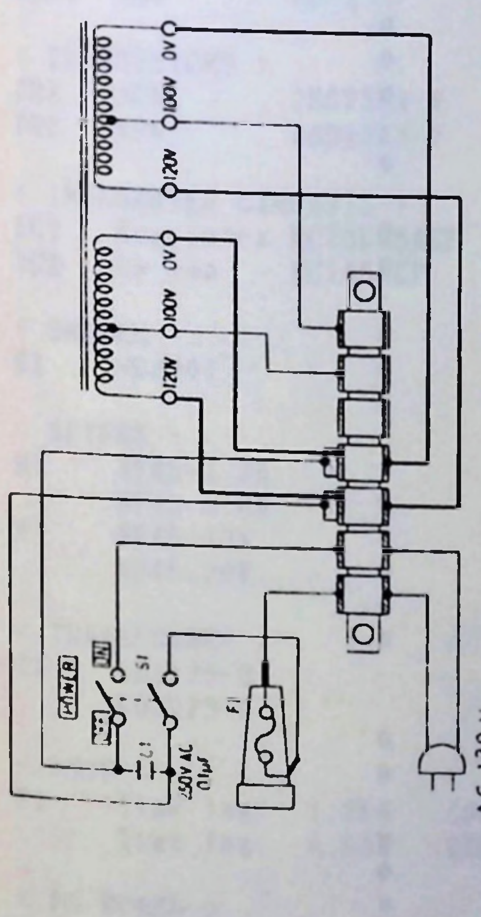
	162A(32V-20A)	163A(32V-30A)	160-3(18V-30A)	160-4(18V-45A)	160-5(18V-55A)
R1	2W 6.8K	3W 3.9K	2W 1.8K	3W 1.2K	3W 1.2K
R6	5W 680	5W 680	5W 220	5W 220	5W 220
R13	1/4W 39K	1/4W 39K	1/4W 22K	1/4W 22K	1/4W 22K
R19	1/4W 20K	1/4W 20K	1/4W 12K	1/4W 12K	1/4W 12K
R23	1/4W 27	1/4W 18	1/4W 27	1/4W 18	1/4W 18
R28	1/4W 9.53KF	1/4W 9.53KF	1/4W 9.53KF	1/4W 9.1KF	1/4W 9.1KF
R34	1/4W 3.01KF	1/4W 3.01KF	1/4W 5.11KF	1/4W 5.11KF	1/4W 5.11KF
R35	1/4W 332F	1/4W 332F	1/4W 562F	1/4W 562F	1/4W 562

	162A(32V-20A)	163A(32V-30A)	160-3(18V-30A)	160-4(18V-45A)	160-5(18V-55A)
R39	10W 0.39	10W 0.27	10W 0.27	10W 0.1	10W 0.1
C3	80V 2200µF×2	80V 3300µF×3	50V 4700µF×2	50V 6800µF×3	50V 6800µF×3
C4	50V 330µF	50V 470µF	50V 330µF	50V 470µF	50V 470µF
D14	1S1588	1S1588	—	—	—
TR1	2SD718	2SC2564	2SD718	2SC2564	2SC2564
TR2	2SD718	2SC2564	2SD718	2SC2564	2SC2564
M1	MF45-2.5A	MF66-4A	MF45-4A	MF66-5.4A	MF66-6A
M2	MF45-40V	MF66-40V	MF45-20V	MF66-20V	MF66-20V

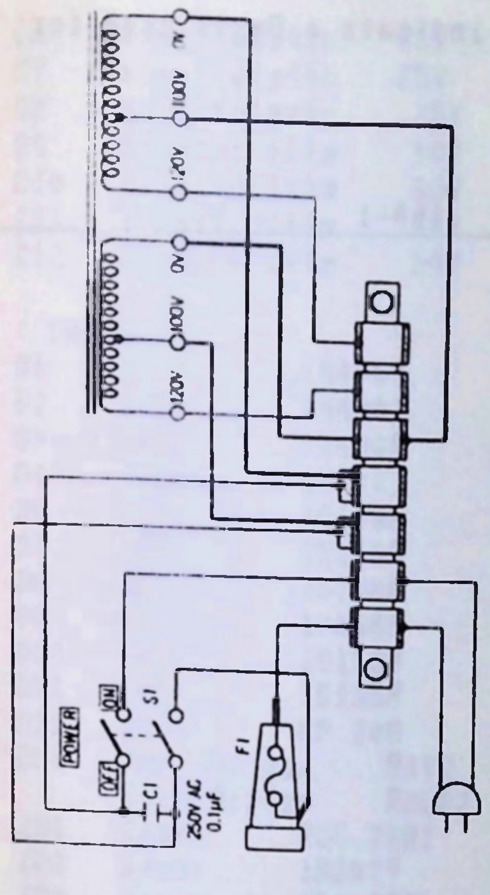
7.3 162A/163A/160-3/160-4/160-5


VOLTAGE
COARSE
FINE
CURRENT
CURR. LIMIT
POWER
AC 100V
MC1458CP
MB4204
AN7808CP
TR1 2SC2564-Y
TR2 2SC2564-Y
TR3 2SC2564-Y
TR4 2SD1362-Y
TR5 2SD553
TD62004P
ERA81-004
1S1588×2
RD6.2EB2
(0 ~ +32V)

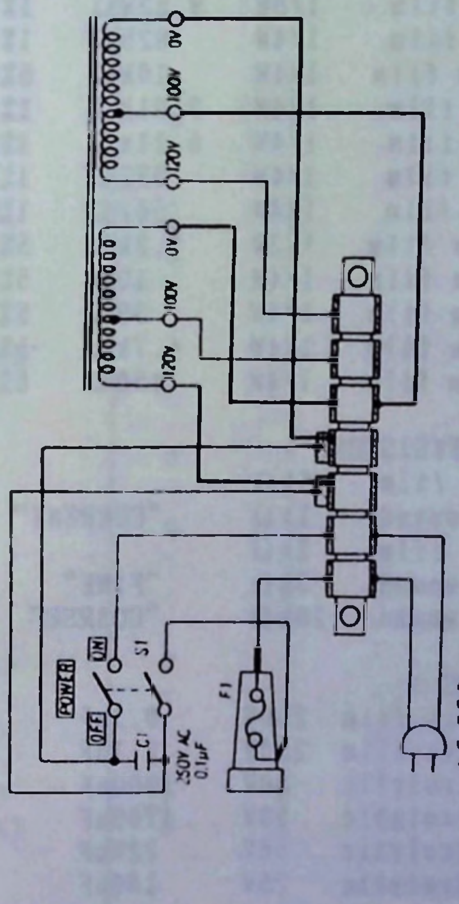
7.5 Power Transformer Primary Wiring



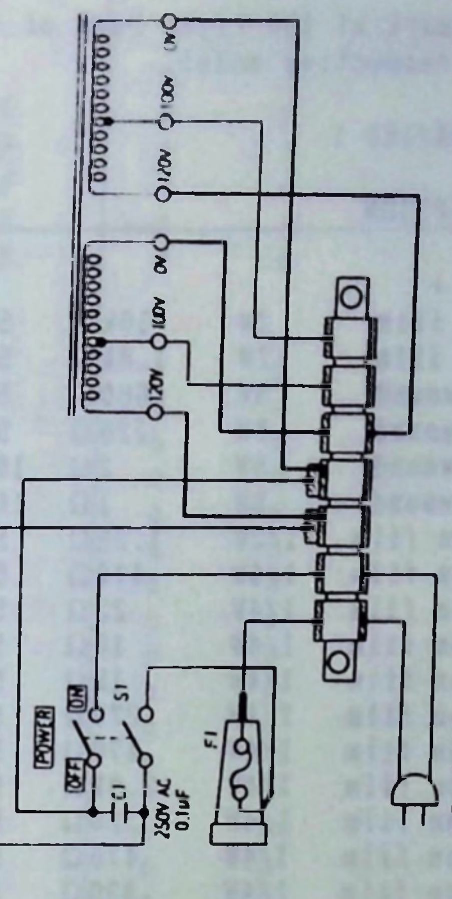
AC 120 V



AC 200 V



AC 220V



AC 240V

NOTE: 100V wiring is illustrated in respective Schematic Diagram.

8. PARTS LIST

* NOTE: "o" mark at the right hand of the list indicats a Parts used for the respective model.

8.1 LPS-160A/160-1

No.	DESCRIPTION				160A	160-1
< RESISTORS >						
R1	Metal film	2W	10kΩ	5%	o	-
	Metal film	2W	1.8kΩ	5%	-	o
R4	Wire wound	5W	680Ω	5%	o	-
	Wire wound	5W	220Ω	5%	-	o
R5	Wire wound	5W	2Ω	10%	o	-
	Wire wound	5W	1Ω	10%	-	o
R6	Carbon film	1/2W	1.2kΩ	5%	o	o
R14	Carbon film	1/4W	470Ω	5%	o	o
R15	Carbon film	1/4W	22Ω	5%	o	-
	Carbon film	1/4W	10Ω	5%	-	o
R16	Carbon film	1/4W	1kΩ	5%	o	o
R17	Carbon film	1/4W	270Ω	5%	o	-
	Carbon film	1/4W	470Ω	5%	-	o
R18	Carbon film	1/4W	3.9kΩ	5%	o	o
R19	Carbon film	1/4W	220Ω	5%	o	-
	Carbon film	1/4W	470Ω	5%	-	o
R20	Carbon film	1/4W	330Ω	5%	o	o
R21	Metal film	1/4W	9.1kΩ	1%	o	-
	Metal film	1/8W	9.53kΩ	1%	-	o
R22	Metal film	1/4W	825Ω	1%	o	o
R23	Carbon film	1/4W	10kΩ	5%	o	o
R24	Metal film	1/4W	3.01kΩ	1%	o	-
	Metal film	1/4W	5.11kΩ	1%	-	o
R25	Metal film	1/4W	332Ω	1%	o	-
	Metal film	1/4W	562Ω	1%	-	o
R26	Carbon film	1/2W	1.2kΩ	5%	o	o
R27	Carbon film	1/4W	10Ω	5%	o	-
	Carbon film	1/4W	39Ω	5%	-	o
R28	Carbon film	1/4W	4.7kΩ	5%	o	o
R29	Carbon film	1/4W	150Ω	5%	o	o
< VARIABLE RESISTORS >						
VR2	Metal film	5kΩ			o	o
VR3	Wire wound	1kΩ	"CURRENT"		o	o
VR4	Metal film	2kΩ			o	o
VR5	Wire wound	3kΩ	"FINE"		o	o
VR6	Wire wound	20kΩ	"COARSE"		o	o
< CAPACITORS >						
C1	Plastic film	250V	0.1uF		o	o
C2	Plastic film	250V	0.1uF		o	o
C3	Electrolytic	80V	1000uF		o	-
	Electrolytic	50V	4700uF		-	o
C4	Electrolytic	50V	220uF		o	o
C5	Electrolytic	25V	100uF		o	o

No.	DESCRIPTION				160A	160-1
C6	Electrolytic	35V		4.7uF	o	o
C7	Electrolytic	25V		10uF	o	o
C8	Electrolytic	25V		100uF	o	o
C9	Plastic film	50V		0.047uF	o	o
C10	Plastic film	50V		0.047uF	o	o
C11	Plastic film	50V		0.0022uF	o	o
C12	Plastic film	50V		0.033uF	o	o
< DIODES >						
D1	Rect	1N4001			o	o
D2	Rect	1N4001			o	o
D3	Rect	1N4001			o	o
D4	Rect	1N4001			o	o
D6	Det	1S1588			o	o
D7	Det	1S1588			o	o
D8	Det	1S1588			o	o
D9	Det	1S1588			o	o
D10	Det	1S1588			o	o
D11	Det	1S1588			o	o
D12	Rect	GP 20B			o	o
DS1	Rect Bridge		S4VB		o	-
	Rect Bridge		KBL02		-	o
ZD1	Zener	RD6.2EB2		6.2V	o	o
ZD2	Zener	1SZ57		6.5V	o	o
ZD3	Zener	RD8.2EB1		8.2V	o	o
LED1	LED	DB-1		Green	o	o
< TRANSISTORS >						
TR1	NPN	2SC2564-Y			o	o
TR2	NPN	2SD1362-Y			o	o
< INTEGRATED CIRCUITS >						
IC1	Regulator	MC78L08ACP		+8V	o	o
IC2	Op amp	MC1458CP			o	o
< SWITCH >						
S1	WD2201			"POWER"	o	o
< METERS >						
M1	MF45-1.2A			"A"	o	-
	MF45-0.6A			"A"	-	o
M2	MF45-40V			"V"	o	-
	MF45-20V			"V"	-	o
< TRANSFORMER >						
T1	LD1123-3				o	-
	LD0223-3				-	o
< FUSE >						
F1	Time lag	1.25A		(90V-132V)	o	o
	Time lag	0.63A		(180V-264V)	o	o
< PC BOARD >						
	ETP094-B				o	o

8.2 LPS-161A/160-2

No.	DESCRIPTION				161A	160-2
< RESISTORS >						
R1	Metal film	2W	5.6kΩ	5%	0	-
	Metal film	2W	1.8kΩ	5%	-	0
R4	Wire wound	5W	680Ω	5%	0	-
	Wire wound	5W	220Ω	5%	-	0
R5	Wire wound	5W	0.82Ω	10%	0	-
	Wire wound	5W	0.47Ω	10%	-	0
R6	Carbon film	1/2W	1.2kΩ	5%	0	0
R7	Carbon film	1/4W	1.2kΩ	5%	0	0
R8	Carbon film	1/4W	1kΩ	5%	0	0
R9	Carbon film	1/4W	2.2kΩ	5%	0	0
R10	Carbon film	1/4W	33Ω	5%	0	0
R11	Carbon film	1/4W	150kΩ	5%	0	0
R12	Carbon film	1/4W	24kΩ	5%	0	-
	Carbon film	1/4W	12kΩ	5%	-	0
R13	Carbon film	1/4W	6.8kΩ	5%	0	-
	Carbon film	1/4W	8.2kΩ	5%	-	0
R14	Carbon film	1/4W	470Ω	5%	0	0
R15	Carbon film	1/4W	10Ω	5%	0	0
R16	Carbon film	1/4W	1kΩ	5%	0	0
R17	Carbon film	1/4W	470Ω	5%	0	0
R18	Carbon film	1/4W	3.9kΩ	5%	0	-
	Carbon film	1/4W	2.7kΩ	5%	-	0
R19	Carbon film	1/4W	470Ω	5%	0	0
R20	Carbon film	1/4W	330Ω	5%	0	0
R21	Metal film	1/4W	9.1kΩ	1%	0	-
	Metal film	1/8W	9.53kΩ	1%	-	0
R22	Metal film	1/4W	825Ω	1%	0	0
R23	Carbon film	1/4W	10kΩ	5%	0	0
R24	Metal film	1/4W	5.11kΩ	1%	0	-
	Metal film	1/4W	3.01kΩ	1%	-	0
R25	Metal film	1/4W	332Ω	1%	0	-
	Metal film	1/4W	562Ω	1%	-	0
R26	Carbon film	1/4W	470Ω	5%	0	0
R27	Carbon film	1/4W	39Ω	5%	0	0
R28	Carbon film	1/4W	4.7kΩ	5%	0	0
R29	Carbon film	1/4W	150Ω	5%	0	0
R30	Carbon film	1/4W	330Ω	5%	0	0
< VARIABLE RESISTORS >						
VR1	Metal film	5kΩ			0	0
VR2	Metal film	5kΩ			0	0
VR3	Wire wound	1kΩ	"CURRENT"		0	0
VR4	Metal film	2kΩ			0	0
VR5	Wire wound	3kΩ	"FINE"		0	0
VR6	Wire wound	20kΩ	"COARSE"		0	0
< CAPACITORS >						
C1	Plastic film	250V	0.1uF		0	0
C2	Plastic film	250V	0.1uF		0	0

No.	DESCRIPTION				161A	160-2
C3	Electrolytic	80V	3300uF		0	-
	Electrolytic	50V	10000uF		-	0
C4	Electrolytic	50V	220uF		0	0
C5	Electrolytic	25V	220uF		0	-
	Electrolytic	25V	100uF		-	0
C6	Electrolytic	35V	4.7uF		0	0
C7	Electrolytic	25V	10uF		0	0
C8	Electrolytic	25V	100uF		0	-
	Plastic film	25V	47uF		-	0
C9	Plastic film	50V	0.047uF		0	0
C10	Plastic film	50V	0.047uF		0	0
C11	Plastic film	50V	0.0022uF		0	0
C12	Plastic film	50V	0.033uF		0	0
C13	Electrolytic	35V	4.7uF		0	0
< DIODES >						
D1	Rect	1N4001			0	0
D2	Rect	1N4001			0	0
D3	Rect	1N4001			0	0
D4	Rect	1N4001			0	0
D5	Rect	1N4001			0	0
D6	Det	1S1588			0	0
D7	Det	1S1588			0	0
D8	Det	1S1588			0	0
D9	Det	1S1588			0	0
D10	Det	1S1588			0	0
D11	Det	1S1588			0	0
D12	Rect	GP 20B			0	0
DS1	Rect Bridge	S4VB			0	0
ZD1	Zener	RD6.2EB2		6.2V	0	0
ZD2	Zener	1SZ57		6.5V	0	0
ZD3	Zener	RD8.2EB1		8.2V	0	0
ZD4	Zener	RD13EB2		13V	0	0
LED1	LED	DB-1		Green	0	0
< TRANSISTORS >						
TR1	NPN	2SC2564-Y			0	0
TR2	NPN	2SD843-Y			0	0
TR3	NPN	2SC1815-Y			0	0
TR4	NPN	2SC1815-Y			0	0
TR5	NPN	2SD553			0	0
< INTEGRATED CIRCUITS >						
IC1	Regulator	MC78L08ACP		+8V	0	0
IC2	Op amp	MC1458CP			0	0
< SWITCHES >						
S1	WD2201			"POWER"	0	0
RY1	Relay	L212HE			0	0
< METERS >						
M1	MF45-1.5A			"A"	0	-
	MF45-2.5A			"A"	-	0

No.	DESCRIPTION		161A	160-2
M2	MF45-40V	"V"	0	-
	MF45-20V	"V"	-	0
	< TRANSFORMER >			
T1	LD0321-3		0	0
	< FUSE >			
F1	Time lag 1.5A	(90V-132V)	0	0
	Time lag 0.8A	(180V-264V)	0	0
	< PC BOARD >			
	ETP094-B		0	0

8.3 LPS-162A/163A/160-3/160-4/160-5

No.	DESCRIPTION				162A	163A	160-3	160-4	160-5
	< RESISTORS >								
R1	Metal film	2W	6.8kΩ	5%	0	-	-	-	-
	Metal film	3W	3.9kΩ	5%	-	0	-	-	-
	Metal film	2W	1.8kΩ	5%	-	-	0	-	-
	Metal film	3W	1.2kΩ	5%	-	-	-	0	0
R4	Wire wound	2W	0.1Ω	10%	0	0	0	0	0
R5	Wire wound	2W	0.1Ω	10%	0	0	0	0	0
R6	Wire wound	5W	680Ω	5%	0	0	-	-	-
	Wire wound	5W	220Ω	5%	-	-	0	0	0
R7	Carbon film	1/2W	1.2kΩ	5%	0	0	0	0	0
R8	Carbon film	1/4W	1.2kΩ	5%	0	0	0	0	0
R9	Carbon film	1/4W	330Ω	5%	0	0	0	0	0
R10	Carbon film	1/4W	1.2kΩ	5%	0	0	0	0	0
R11	Carbon film	1/4W	15Ω	5%	0	0	0	0	0
R12	Carbon film	1/4W	150kΩ	5%	0	0	0	0	0
R13	Carbon film	1/4W	39kΩ	5%	0	0	-	-	-
	Carbon film	1/4W	22kΩ	5%	-	-	0	0	0
R14	Carbon film	1/4W	1.2kΩ	5%	0	0	0	0	0
R15	Carbon film	1/4W	330Ω	5%	0	0	0	0	0
R16	Carbon film	1/4W	1.2kΩ	5%	0	0	0	0	0
R17	Carbon film	1/4W	15Ω	5%	0	0	0	0	0
R18	Carbon film	1/4W	150kΩ	5%	0	0	0	0	0
R19	Carbon film	1/4W	20kΩ	5%	0	0	-	-	-
	Carbon film	1/4W	12kΩ	5%	-	-	0	0	0
R20	Carbon film	1/4W	8.2kΩ	5%	0	0	0	0	0
R21	Carbon film	1/4W	8.2kΩ	5%	0	0	0	0	0
R22	Carbon film	1/4W	470Ω	5%	0	0	0	0	0
R23	Carbon film	1/4W	27Ω	5%	0	-	0	-	-
	Carbon film	1/4W	18Ω	5%	-	0	-	0	0
R24	Carbon film	1/4W	3.9kΩ	5%	0	0	0	0	0
R25	Carbon film	1/4W	470Ω	5%	0	0	0	0	0
R26	Carbon film	1/4W	330Ω	5%	0	0	0	0	0

No.	DESCRIPTION					162A	163A	160-3	160-4	160-5
R27	Carbon film	1/4W	10kΩ	5%		0	0	0	0	0
R28	Metal film	1/8W	9.53kΩ	1%		0	0	0	-	-
	Metal film	1/4W	9.1kΩ	1%		-	-	-	0	0
R29	Metal film	1/4W	825Ω	1%		0	0	0	0	0
R30	Carbon film	1/4W	2.7kΩ	5%		0	0	0	0	0
R32	Carbon film	1/4W	470Ω	5%		0	0	0	0	0
R33	Carbon film	1/4W	4.7kΩ	5%		0	0	0	0	0
R34	Metal film	1/4W	3.01kΩ	1%		0	0	-	-	-
	Metal film	1/4W	5.11kΩ	1%		-	-	0	0	0
R35	Metal film	1/4W	332Ω	1%		0	0	-	-	-
	Metal film	1/4W	562Ω	1%		-	-	0	0	0
R36	Carbon film	1/4W	470Ω	5%		0	0	0	0	0
R37	Carbon film	1/4W	39Ω	5%		0	0	0	0	0
R38	Carbon film	1/4W	150Ω	5%		0	0	0	0	0
R39	Wire wound	10W	0.39Ω	5%		0	-	-	-	-
	Wire wound	10W	0.27Ω	5%		-	0	0	-	-
	Wire wound	10W	0.1Ω	5%		-	-	-	0	0
R40	Carbon film	1/4W	330Ω	5%		0	0	0	0	0
< VARIABLE RESISTORS >										
VR1	Metal film	5kΩ				0	0	0	0	0
VR2	Metal film	5kΩ				0	0	0	0	0
VR3	Metal film	5kΩ				0	0	0	0	0
VR4	Wire wound	1kΩ	"CURRENT"			0	0	0	0	0
VR5	Metal film	2kΩ				0	0	0	0	0
VR6	Wire wound	3kΩ	"FINE"			0	0	0	0	0
VR7	Wire wound	20kΩ	"COARSE"			0	0	0	0	0
< CAPACITORS >										
C1	Plastic film	250V	0.1uF			0	0	0	0	0
C2	Plastic film	250V	0.1uF			0	0	0	0	0
C3	Electrolytic	80V	2200uF			0	-	-	-	-
	Electrolytic	80V	3300uF			-	0	-	-	-
	Electrolytic	50V	4700uF			-	-	0	-	-
	Electrolytic	50V	6800uF			-	-	-	0	0
C4	Electrolytic	50V	330uF			0	-	0	-	-
	Electrolytic	50V	470uF			-	0	-	0	0
C5	Electrolytic	25V	470uF			0	0	0	0	0
C6	Electrolytic	35V	4.7uF			0	0	0	0	0
C7	Electrolytic	25V	10uF			0	0	0	0	0
C8	Electrolytic	25V	100uF			0	0	0	0	0
C9	Plastic film	50V	0.047uF			0	0	0	0	0
C10	Plastic film	50V	0.047uF			0	0	0	0	0
C11	Plastic film	50V	0.0022uF			0	0	0	0	0
C12	Plastic film	50V	0.0022uF			0	0	0	0	0
C13	Electrolytic	35V	4.7uF			0	0	0	0	0
< DIODES >										
D1	Rect	GP20B				0	0	0	0	0
D2	Rect	1N4001				0	0	0	0	0
D3	Rect	1N4001				0	0	0	0	0
D4	Rect	1N4001				0	0	0	0	0
D5	Rect	1N4001				0	0	0	0	0

No.	DESCRIPTION			162A	163A	160-3	160-4	160-5
D6	Rect	1N4001		0	0	0	0	0
D7	Rect	1N4001		0	0	0	0	0
D8	Det	1S1588		0	0	0	0	0
D9	Det	1S1588		0	0	0	0	0
D10	Det	1S1588		0	0	0	0	0
D11	Det	1S1588		0	0	0	0	0
D12	Det	1S1588		0	0	0	0	0
D13	Det	1S1588		0	0	0	0	0
D14	Det	1S1588		0	0	0	0	0
DS1	Rect Bridge	KBU8D		0	0	-	-	-
ZD1	Zener	RD6.2EB2	6.2V	0	0	0	0	0
ZD2	Zener	1SZ57	6.5V	0	0	0	0	0
ZD3	Zener	RD8.2EB1	8.2V	0	0	0	0	0
ZD4	Zener	RD13EB2	13V	0	0	0	0	0
LED1	LED	DB-1	Green	0	0	0	0	0
< TRANSISTORS >								
TR1	NPN	2SD718		0	-	0	-	-
	NPN	2SC2564		-	0	-	0	0
TR2	NPN	2SD718		0	-	0	-	-
	NPN	2SC2564		-	0	-	0	0
TR3	NPN	2SC2274-E		0	0	0	0	0
TR4	NPN	2SC1815-Y		0	0	0	0	0
TR5	NPN	2SD592A-S		0	0	0	0	0
TR6	NPN	2SC1815-Y		0	0	0	0	0
TR7	NPN	2SD1411		0	0	0	0	0
TR8	NPN	2SD523		0	0	0	0	0
< INTEGRATED CIRCUITS >								
IC1	Regulator	MC78L08ACP	+8V	0	0	0	0	0
IC2	Op amp	MC1458CP		0	0	0	0	0
< SWITCHES >								
S1	WD2201		"POWER"	0	0	0	0	0
RY1	Relay	VS12TBN-E		0	0	0	0	0
RY2	Relay	VS12TBN-E		0	0	0	0	0
< METERS >								
M1	MF45-2.5A		"A"	0	-	-	-	-
	MF66-4A		"A"	-	0	-	-	-
	MF45-4A		"A"	-	-	0	-	-
	MF66-5.4A		"A"	-	-	-	0	-
	MF66-6.4A		"A"	-	-	-	-	0
M2	MF45-40V		"V"	0	-	-	-	-
	MF66-40V		"V"	-	0	-	-	-
	MF45-20V		"V"	-	-	0	-	-
	MF66-20V		"V"	-	-	-	0	0
< TRANSFORMER >								
T1	LD0221-3			0	0	0	0	0

No.	DESCRIPTION			162A	163A	160-3	160-4	160-5
< FUSE >								
F1	Time lag	2A	(90V-132V)	0	-	0	-	-
	Time lag	1A	(180V-264V)	0	-	0	-	-
	Time lag	2.5A	(90V-132V)	-	0	-	-	-
	Time lag	1.25A	(180V-264V)	-	0	-	-	-
	Time lag	3A	(90V-132V)	-	-	-	0	0
	Time lag	1.5A	(180V-264V)	-	-	-	0	0
< PC BOARD >								
	ETP101-C			0	0	-	-	-
	ETP095-A			-	-	0	0	0

8.4 LPS-164A

No.	DESCRIPTION			
< RESISTORS >				
R1	Metal film	3W	3.9kΩ	5%
R2	Carbon film	1/4W	39Ω	5%
R3	Carbon film	1/4W	4.7kΩ	5%
R4	Wire wound	5W	0.1Ω	10%
R5	Wire wound	5W	0.1Ω	10%
R6	Wire wound	5W	0.1Ω	10%
R7	Wire wound	5W	680Ω	5%
R8	Wire wound	10W	0.1Ω	10%
R9	Carbon film	1/4W	330Ω	5%
R10	Carbon film	1/4W	1.2kΩ	5%
R11	Carbon film	1/4W	470Ω	5%
R12	Carbon film	1/4W	1kΩ	5%
R13	Carbon film	1/4W	3kΩ	5%
R14	Carbon film	1/4W	15kΩ	5%
R15	Carbon film	1/4W	22kΩ	5%
R16	Carbon film	1/4W	15kΩ	5%
R17	Carbon film	1/4W	330kΩ	5%
R18	Carbon film	1/4W	10kΩ	5%
R19	Carbon film	1/4W	15kΩ	5%
R20	Carbon film	1/4W	39kΩ	5%
R21	Carbon film	1/4W	15kΩ	5%
R22	Carbon film	1/4W	470kΩ	5%
R23	Carbon film	1/4W	10kΩ	5%
R24	Carbon film	1/4W	10kΩ	5%
R25	Carbon film	1/4W	750kΩ	5%
R26	Carbon film	1/4W	56kΩ	5%
R27	Carbon film	1/4W	15kΩ	5%
R28	Carbon film	1/4W	15kΩ	5%
R29	Carbon film	1/4W	10kΩ	5%
R30	Carbon film	1/4W	1MΩ	5%
R31	Carbon film	1/4W	75kΩ	5%
R32	Carbon film	1/4W	15kΩ	5%

No.	DESCRIPTION			
R33	Carbon film	1/4W	15kΩ	5%
R34	Carbon film	1/4W	18Ω	5%
R35	Carbon film	1/4W	470Ω	5%
R36	Carbon film	1/4W	8.2kΩ	5%
R37	Carbon film	1/4W	470Ω	5%
R38	Carbon film	1/4W	470Ω	5%
R39	Carbon film	1/4W	2.7kΩ	5%
R40	Carbon film	1/4W	150Ω	5%
R41	Metsl film	1/4W	825Ω	1%
R42	Metal film	1/4W	9.09kΩ	1%
R43	Metal film	1/4W	332Ω	1%
R44	Carbon film	1/4W	10kΩ	5%
R45	Metal film	1/4W	3.01kΩ	1%
R46	Metal film	1/4W	332Ω	1%

< VARIABLE RESISTORS >

No.	DESCRIPTION		
VR1	Metal film	5kΩ	
VR2	Metal film	2kΩ	
VR3	Wire wound	1kΩ	"CURRENT"
VR4	Wire wound	3kΩ	"FINE"
VR5	Wire wound	20kΩ	"COARSE"

< CAPACITORS >

No.	DESCRIPTION		
C1	Plastic film	250V	0.1uF
C2	Plastic film	250V	0.1uF
C3	Electrolytic	80V	22000uF
C4	Electrolytic	50V	470uF
C5	Electrolytic	25V	470uF
C6	Electrolytic	35V	4.7uF
C7	Electrolytic	25V	10uF
C8	Electrolytic	35V	4.7uF
C9	Electrolytic	25V	330uF
C10	Plastic film	50V	0.047uF
C11	Plastic film	50V	0.047uF
C12	Electrolytic	25V	100uF
C13	Plastic film	50V	0.047uF
C14	Plastic film	50V	0.0022uF
C15	Plastic film	50V	0.047uF
C16	Plastic film	50V	0.047uF
C17	Plastic film	50V	0.033uF
C18	Plastic film	50V	0.047uF

< DIODES >

No.	DESCRIPTION	
D1-1	Rect	GP30B
D1-2	Rect	GP30B
D2	Rect	1N4001
D3	Rect	1N4001
D4	Rect	1N4001
D5	Rect	1N4001
D6	Schottky	ERA81-004
D7	Schottky	ERA81-004
D8	Schottky	ERA81-004
D9	Schottky	ERA81-004

No.	DESCRIPTION		
D10	Det	1S1588	
D11	Det	1S1588	
D12	Det	1S1588	
D13	Det	1S1588	
D14	Det	1S1588	
D15	Det	1S1588	
DS1	Rect Bridge	S15VB20	
ZD1	Zener	RD13EB2	13V
ZD2	Zener	RD8.2EB1	8.2V
ZD3	Zener	RD6.2EB2	6.2V
ZD4	Zener	1SZ58	6.5V
LED1	LED	DB-1	Green
< TRANSISTORS >			
TR1	NPN	2SC2564-Y	
TR2	NPN	2SC2564-Y	
TR3	NPN	2SC2564-Y	
TR4	NPN	2SD1362-Y	
TR5	NPN	2SD553	
TRA1	Transistor array	TD62004P	
< INTEGRATED CIRCUITS >			
IC1	Regulator	MC78L08ACP	+8V
IC2	Op amp	MC1458CP	
IC3	Comparator	MB42041	
< SWITCHES >			
S1	WD2201		"POWER"
RY1	Relay	VS12TBN-E	
RY2	Relay	VS12TBN-E	
RY3	Relay	VS12TBN-E	
RY4	Relay	VS12TBN-E	
< METERS >			
M1	KB-75 6A		"A"
M2	KB-75 40V		"V"
< TRANSFORMER >			
T1	LD1523-3		
< FUSE >			
F1	Time lag	5A	(90V-132V)
	Time lag	2.5A	(180V-264V)
< PC BOARD >			
	ETP123-A		
	ETP124-A		

9. TOP COVER REMOVAL

- Take ten phillips screws off from both side of the unit to remove the Top Cover.